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ABSTRACT

This document presents a model for predicting (1) school district spending per pupil, and (2) the effect of alternative forms of school aid. Constrained maximization equations take account of (1) real expenditure per pupil; (2) real school taxes, income taxes, and nonschool property taxes per household; and (3) homeowner's proportion of property tax. The model shows that matching grants stimulate more local expenditure than the customary lump sums. Regardless, the impact on spending per pupil is proportional to the number of pupils per household--not to aid per pupil. To predict results of matching grants, States can judge by the response of spending per pupil to changes in costs over time. An incomplete version of the model accounted for some 80 percent of the variance in school expenditure among States during 1954-1956, and, unlike earlier models, gave results consistent from year to year. (Author)

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THE IMPACT OF GRANTS-IN-AID ON STATE AND LOCAL EDUCATION EXPENDITURES

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One year ago, The Rand Corporation received a grant from the Ford Foundation to carry out a study of fiscal impacts of state and federal aid to local governments. The study was to address itself primarily to the decision problem faced by the grantor of aid, that is, the state or federal supplier of funds, in trying to choose among alternative forms of support to bring about desired expenditure patterns at the local level. To aid grantor agencies in making those decisions, we proposed to develop analytical tools or models that could be used to estimate the fiscal impacts of alternative aid formulas, thus providing a base of information for making comparisons among rival proposals.

For concreteness, we decided to focus on one broad category of state-local spending rather than attempt to study intergovernmental fiscal relations in general. We selected public elementary and secondary education as the study area because it is the largest state-local program in terms of both expenditure levels and the volume of intergovernmental transactions, and because of complementary Rand work in a variety of education studies. Therefore, what this paper reports on is essentially a study of the impact of alternative forms of intergovernmental aid to education on local school district spending.

This is a timely subject in terms of the current situation in school finance. There are changes taking place and pressures for change in

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educational finance across the country, at both state and federal levels. Last year, in California alone, at least eight different proposals to alter the method of financing public education were placed before the Legislature. Each proposal would have modified either the provisions for apportioning state aid or the system for raising school taxes, and would have affected both the average level of per pupil spending in the state and the distribution of per pupil spending among districts. But in the absence of any analytical capability for estimating local responses to the proposed changes, there is no way to assess or compare their full effects on either aggregate spending or the expenditure distribution. We do not know by how much local school districts will raise or lower their own tax effort in response to a new formula; hence, we do not know what new fiscal patterns would emerge.

Of course, California is not unique. There are proposals in many other states for modifying--hopefully, for improving--school aid formulas. There are also a number of proposals for instituting general-purpose aid at the federal level. In other words, there are arrays of alternatives facing state legislatures, state departments of education, and the Congress. In none of these arenas is there sufficient information at hand to assess the fiscal implications of the various alternatives. In all of them, there is at least a probability that better decisions may result if a capability is established for estimating and comparing the fiscal consequences of proposed courses of action.

NATURE OF THE STUDY

The work we are carrying on at Rand belongs to a growing body of economic research on determinants of public spending and the effects of intergovernmental aid. This research deals with fiscal behavior not only of school systems but also of states, municipalities, and county governments. Fortunately for those working in the field, it appears that similar models can be applied to these different jurisdictions. This means that the whole body of research--not only those studies that deal specifically with education--can be drawn on in developing fiscal impact models for school districts.

Some of the work on expenditure determinants has been carried on within the education finance community; for example, the study by H. Thomas James of determinants of educational spending in large city school systems.* But much of the pertinent work has been undertaken by economists working in applied public finance. In recent years, the *National Tax Journal* has been the largest single source of literature in this field.†

An important trend in the field is that it is becoming noticeably more theoretical. A few years ago, most of the work was highly empirical. A researcher would simply develop regression equations relating per pupil spending to a number of available and plausibly relevant variables, but without reference to an explicit theoretical model. Now the theoretical framework is receiving more attention. This, in my opinion, is a positive development and perhaps a vital development in terms of the long-run success and policy relevance of the research. One of the points that I hope to make in this paper is that the focus on theory is not a mere academic concern. It is a necessary characteristic of the work if the policy objectives mentioned earlier are to be attained.

The project under way at Rand comprises both theoretical and empirical work on the impact of aid. The theoretical part of the study focuses on two approaches to modeling school district fiscal behavior. These are the *constrained maximization* and the *incrementalist* approaches, respectively.

The constrained maximization model derives from an analogy with the economic theory of consumer demand. It says that the governmental unit--a school district--faces certain trade-off possibilities between things it values, such as better quality of education on one hand and a lower level of taxes on the other, and that it tries to reach an optimal compromise. If the district behaves in what we like to call a

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*H. Thomas James, J. Alan Thomas, and Walter I. Garms, *Determinants of Educational Expenditures in Large Cities of the United States*, U.S. Office of Education, Cooperative Research Project No. 2389, Stanford University, School of Education, 1966.

†For references, see J. A. Wilde, "The Expenditure Effects of Grant-in-Aid Programs," *National Tax Journal*, Vol. XXI, No. 3, September 1968.

"rational" way, that is, if it has consistent preferences of a certain kind, then the idea of maximizing behavior leads to a number of empirically testable inferences about the response of per pupil spending to changes in financial aid or other external variables. This approach has been used by a number of writers in attempting to develop a theory of local government spending.*

In contrast, the incrementalist model+ is more directly behavioral. It says that school district expenditures in the current year equal school district expenditures of last year plus an incremental adjustment in response to altered conditions. The focus is on the annual increment in spending and on the discovery of the *de facto* rules of budgetary behavior that a district follows. Of the two approaches, the incrementalist model is less abstract, more dynamic, and perhaps in some senses more realistic, but it is much more limited in predictive power. The constrained maximization approach has greater capacity for dealing systematically with a large number of influences on spending and for estimating the effects of changes in external circumstances. In the discussion that follows, I shall concentrate on the first approach and shall attempt to illustrate how predictive models can be derived from the constrained maximization theory.

The empirical part of the project centers on development of econometric models of educational spending by school districts and states. One part of that work is an analysis of interstate variations in statewide school spending. Another part is an analysis of variations in per pupil spending among districts within individual states, using data for New York State and California school districts. An important characteristic of both parts is that we are using both time series (longitudinal) and cross-section data to estimate effects of the various

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*For example, see Alan Williams, *Public Finance and Budgeting Policy* (Praeger, 1963), pp. 171-180; James A. Wilde, op. cit; and Gail S. R. Wilensky, "State Aid to Education," unpublished Ph.D. dissertation, University of Michigan, 1968.

+As developed, for example, in O. A. Davis, M.A.H. Dempster, and A. Wildavsky, "A Theory of the Budgetary Process," *The American Political Science Review*, Vol. LX, No. 3, September 1966.

explanatory variables. In this respect the work differs from most studies of expenditure determinants, which have been limited to single-year, cross-sectional analyses. The longitudinal dimension turns out to be quite important in accounting for certain aspects of fiscal behavior, as will be explained later.

Regarding the current status of the work, the theoretical portion is now essentially completed; the empirical work is still under way. Accordingly, the remainder of the paper will deal mainly with the theoretical models and some of their empirical implications, but not with quantitative policy implications, which cannot be examined until the econometric work is completed.

A THEORETICAL MODEL OF SCHOOL DISTRICT EXPENDITURES

As a way of conveying the flavor of the analytical approach, I will trace through the development of one particular model of school district fiscal behavior. This model belongs to the constrained maximization category. To distinguish it from other models of that family and to give it a descriptive label, I will call it the *education-tax trade-off model*.

The basic concept underlying this model is a very simple one: that a school district, in deciding on its per pupil level of expenditures, faces a trade-off between a higher program level, as measured by real per pupil outlays, and the level of educational taxes per pupil that it must impose on the community. Of course, with any given level of taxes the district would like to have as high a level of per pupil spending as possible, and with a given expenditure level it would like to have the smallest possible tax rate; but the important question is how the district is willing to trade off the two: higher expenditures, which are valued, versus higher tax levels, which have obvious political disutility to the district decisionmaker.

District preferences with regard to expenditure levels versus tax levels may be described in terms of a ratio called the *marginal rate of trade-off*. This ratio measures the amount of per pupil tax that a district would be willing to impose in order to raise per pupil expenditure by one dollar. For example, a district spending $800 per pupil

and taxing at a rate of $500 per pupil might be willing to increase the per pupil tax 60 cents to obtain one more dollar of per pupil spending. The marginal rate would then be $0.60/$1, or $0.6. If the same district were already spending $1000, it might value one additional dollar of spending less highly and be willing to tax itself only 40 cents--a marginal rate of trade-off of 0.4. In general, we would probably expect the ratio to decline with both the expenditure level and the tax level. That is, if a district already had a high level of spending, one additional dollar would seem less urgent; if it already had a high tax level, an additional dollar of tax would seem less palatable.

Graphical Presentation of the Model

These assumptions about a district's willingness to trade off increments in spending for increments in taxes suffice to define a *preference function* for the district. This function cen be represented graphically if variables other than school spending and taxes (e.g., income, prices, and district population) are held constant. In Fig. 1, per pupil spending,* e, is measured horizontally and per pupil taxes

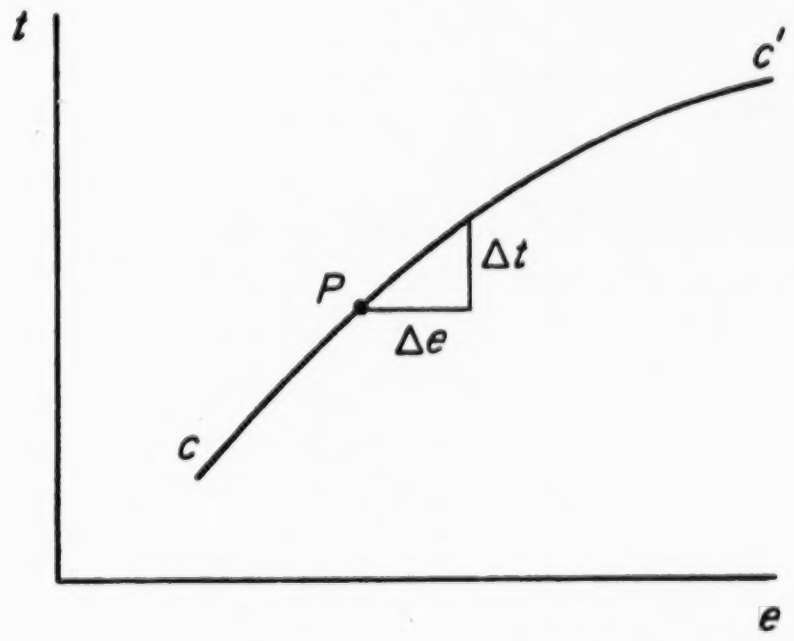

Fig. 1--District behavior in trading off expenditures and taxes

t, are measured vertically. From a given starting point, such as point P, we can represent the marginal rate of trade-off graphically by showing the increment in tax, Δt, that the district would be willing to impose in order to obtain an increment in expenditure, Δe. The *slope* $\Delta t/\Delta e$ is the marginal rate of trade-off.

We have assumed that the marginal rate of trade-off declines as we go to higher levels of taxing or spending. In terms of the diagram, this means that successive increments in e (i.e., movement to the right from point P in Fig. 1) would bring forth successively smaller increments in t. In other words, the district would be willing to support increased outlays only along a diminishing curve, such as CC'. Of course, there is nothing unique about the arbitrary starting point, P. Precisely the same kind of behavior would be expected no matter what point had been selected. Therefore, conceptually, there exists a family of trade-off curves with one curve passing through each point in the diagram, as depicted in Fig. 2.

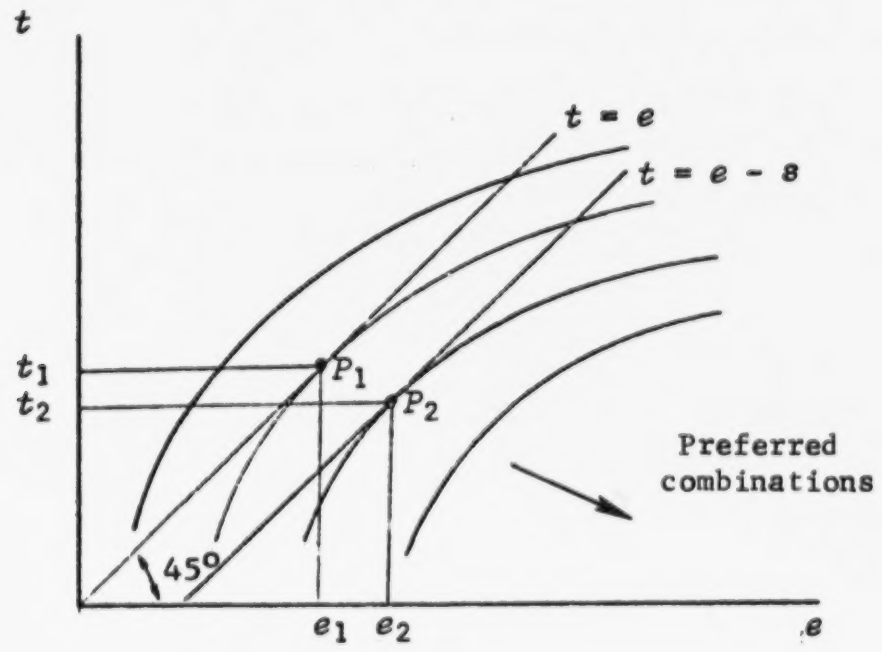

Fig. 2--Tax versus expenditure trade-off model of school district spending

*As used here, the terms *per pupil spending* or *per pupil expenditures* refer to current outlays only. Capital outlays are not included in the analysis.

Since points along the original curve CC' in Fig. 1 represent expenditure-tax combinations to which the district would move voluntarily from the starting point P, they can all be thought of as equally satisfactory to the district. The same is true of points along any other trade-off contour. Thus, each curve represents a locus of equally desirable expenditure-tax combinations. However, as we go from one curve to another in a "southeasterly" direction, as shown in Fig. 2, we get to progressively better and better curves, representing higher expenditure-lower tax combinations.

The basic behavioral premise that leads to a model of expenditure determination is that the district will select the best attainable combination of expenditures and taxes subject to applicable budget constraints. That is, it will select a point along the most "southeasterly" trade-off curve it can reach. This is what is meant by "maximization" in the term "constrained maximization" and it is directly analogous to the idea of utility maximization in consumer economics.

The ability of a district to select a favorable combination of spending and taxes is limited by the existence of a budget constraint. If we neglect capital expenditures and assume that no borrowing is allowed, and also assume for the moment that there is no state or federal aid, then the constraint is simply $t = e$, or per pupil expenditure equals per-pupil taxes. This is represented by a 45 deg line through the origin in Fig. 2. Points on and above the line are accessible to the district, but only points along the line are relevant since for any point off the line there is one on the line that provides greater expenditures for no greater taxes. The "best" attainable point is the point of tangency between the budget constraint line and the highest preference curve that touches that line, i.e., the point P_1, which corresponds to an expenditure level e_1.

Of course, a real district rarely has to levy taxes equal to all the funds it expends because some of its revenues are obtained as aid from state and federal agencies. To a certain extent, the effects of this aid can be studied graphically. If, for example, a flat grant of s dollars of state aid per pupil is provided to the district, the new budget constraint becomes $t = e - s$, which corresponds to a budget

line shifted vertically downward, as shown in Fig. 2. The new "best" combination of taxes and expenditures is at point P_2, corresponding to an expenditure level e_2. The level of per pupil expenditure does not increase by the whole amount of the grant-in-aid, s. Only part of that aid is additive; the remainder becomes a substitute for funds that would have been provided locally had aid not been available. This is reflected in a reduction of the per pupil tax from t_1 to t_2. An important objective of the empirical analysis based on this model is to determine the proportions in which a dollar of state aid translates into increased total outlay and reduced taxes, respectively. Many conflicting estimates of this substitution ratio have appeared in the literature. We hope that careful development of these models will make it possible to obtain a more reliable estimate.

The diagrammatic analysis can be used to study a number of aspects of district response to state aid. For example, it can be used to demonstrate that matching grants are generally more stimulative of local spending than lump-sum grants. It can also be used to study the effects of "floor" and "ceiling" stipulations, minimum tax rate requirements, and other characteristic features of state school aid formulas. However, the two-dimensional diagrams are too restrictive to permit analysis of many other phenomena of interest, such as effects of differences in income, wealth, and costs of education, the proportion of the population in school, the composition of the tax base, and equalization features of aid formulas. Therefore, rather than pursue the graphical analysis, which I have introduced mainly for heuristic purposes, I will now outline the mathematical approach to the theory, which can accommodate many more variables and which admits of direct translation into empirically testable econometric models.

Mathematical Formulation of the Model

A mathematical version of the constrained maximization model of school district expenditure requires the same two elements as the graphical version, namely, a description of the district's behavior in trading off expenditures versus taxes and a budget constraint relationship.

With these two elements it is possible to derive a number of quantitative implications of maximizing behavior.

Beginning with the trade-off relationship, let us use the symbol m to represent the marginal rate of trade-off between spending and taxing. Our assumption in connection with the diagrammatic analysis was that the trade-off ratio at any given point depends on the initial values of per pupil expenditure and per pupil tax; i.e., it was assumed that $m = m(e, t)$. However, in order to obtain so simple a relationship--one that could be represented two-dimensionally--it was necessary to assume that all other variables that might affect m were held constant. But now, with a mathematical formulation, we are free to include a number of these variables explicitly, and thus to study a number of important economic and demographic influences on levels of school expenditure.

To illustrate the rationale for incorporating additional variables into the model, consider the following propositions about factors affecting the willingness of a district to tax itself in exchange for additional school expenditures:

1. A district's willingness to raise taxes in order to raise expenditures, given the initial levels of those two variables, increases with community income or wealth--i.e., of two communities starting at the same point, the wealthier would probably be willing to accept a great per capita tax increase for a unit increment in real educational outlay per pupil.
2. Local willingness to incur school taxes to obtain higher expenditures depends on (a) the proportion of the local tax burden to be borne by homeowners as opposed to businesses (the greater that proportion, presumably, the less the willingness of the community to tax itself), and (b) on the levels of other property taxes imposed on the community (the higher the level of other taxes, the less willingness to raise taxes for education). Note that the last proposition allows for treatment of the frequently cited "municipal overburden" problem as an integral part of the analysis.

To express these propositions mathematically, we define a marginal rate of trade-off function:

$$m(e, t_e; y - t_y, h, t_g),$$

where m is the marginal rate of trade-off between school taxes and expenditures, as defined earlier, and

e = real educational expenditure per pupil,

t_e = real local school taxes (property taxes) levied per household,

y = real personal income per household,

t_y = real income taxes per household (federal and state)*

h = proportion of the local school tax borne by homeowners,

t_g = real nonschool property taxes per household.

The household has been arbitrarily selected as the economic unit for analysis. Therefore, economic magnitudes, such as income and taxes, are stated as amounts per household. We could just as well have selected individuals in the community as the basic units and stated all magnitudes in per capita terms. However, the former proves to be more convenient later in the analysis. Note that the variable for school taxes has also been redefined in per household terms. This means that the marginal rate of trade-off now refers to the rate at which a district is willing to increase school taxes per *household*, rather than per pupil to obtain higher per pupil spending.

Two other features to note about this formulation are (a) that all the dollar variables entering into the model are defined in "real" terms, i.e., in constant dollars, and (b) that of all the variables in the expression for m, only the two to the left of the semicolon can be determined by district decisionmakers; the others are exogenous school district or community characteristics.

Our assumptions about the signs of the effects of the variables entering into the trade-off function translate into the following stipulations about its partial derivatives:

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*The quantity $y - t_y$ is real *disposable* income per household.

$$\frac{\partial m}{\partial e} < 0, \frac{\partial m}{\partial t_e} < 0, \frac{\partial m}{\partial (y-t_y)} > 0, \frac{\partial m}{\partial h} < 0, \frac{\partial m}{\partial t_g} < 0.$$

That is, district willingness to pay additional taxes for additional school expenditures declines with the level of expenditures, the level of taxes, the proportion of taxes paid by homeowners, and the level of other property taxes; it increases with real disposable income per household.

The budget constraint is still nothing more than a statement that school district spending equals school district revenue. However, in writing the budget equation, we have to allow for the existence of state or federal aid. Also, since the key variables are defined in constant dollars, we have to allow for the possibility that both the unit cost, or price, of educational resources and the general price level will vary among districts. Taking both factors into account, the budget constraint equation may be written:

$$p_e Ae = p_x Nt + p_e As,$$

i.e., total expenditure = total local taxes + total state aid. The new variables appearing in the equation are p_e, the price per unit of educational resources; p_x, the general price level; A, the number of pupils enrolled; N, the number of households in the district; and s, the real value of per pupil state aid to the local school district.* As indicated by the association of p_e with s, the real value of state aid is measured in terms of its *educational* purchasing power. For convenience, we can solve this equation for t_e and rewrite it as

$$t_e = \frac{p_e A}{p_x N}(e - s) = pa(e - s),$$

where $a = A/N$, the average number of pupils per household, and p is defined as p_e/p_x, the *relative price* of education.

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*To keep the exposition simple, only state aid will be included in the model. An analysis of the effects of federal aid would proceed along parallel lines.

State Aid Formulas. Having defined the budget constraint, we are also in a position to introduce an explicit state aid formula into the model. In general, the amount of state aid, s, provided per pupil will depend on the amount of property value per pupil in the district, as is the case under most equalization plans, and/or the level of per pupil expenditures, as is the case whenever an aid formula contains matching provisions. Therefore, a general functional expression for a state aid formula is

$$s = s(v, e)$$

where v is the assessed property value per pupil in the district. However, there is no need to work at such a high level of abstraction. In virtually every state the aid formula consists of one or more of the following three components:

1. A flat per-pupil grant.
2. An equalized per-pupil grant, in which the amount of the grant is inversely related to wealth (assessed property value) per pupil, as in a foundation program.
3. A matching grant, in which the *local share* is inversely related to wealth (assessed property value) per pupil, as in a variable percentage matching plan.

In California, for example, all three of these are present in the forms of "basic aid," "equalization aid," and "supplementary aid," respectively. From the point of view of an individual district, state aid will have the form:

$$s = f + (1 - c)e,$$

where f is the total amount paid to the district as a "lump sum," including any aid provided either as a flat grant or an equalized per-pupil grant, and c is the local share of expenditures required by a matching formula. But when we compare across districts, both f and c are seen to depend on the value of v, the amount of property value per pupil in a district. That is, $f = f(v)$ and $c = c(v)$, with $\partial f/\partial v < 0$ if there is an equalized foundation program and $\partial c/\partial v > 0$ if there is variable percentage matching.

We can combine the aid formula with the budget equation to obtain a new budget identity:

$$t_e = pa[e - f - (1 - c)e] = pa(ce - f),$$

which is the form that will actually be incorporated into the model.

Maximization. In the graphical exposition of the theory, maximizing behavior was shown to imply movement toward a point of tangency between a preference contour and the budget constraint line. The mathematical counterpart of that tangency condition is the requirement that the marginal rate of trade-off between taxes and expenditures be equal to the slope of the budget constraint. From the above equation for t_e, that slope is

$$\frac{dt_e}{de} = pac.$$

Therefore, the maximization condition is

$$m(e, t_e; y - t_y, h, t_g) = pac.$$

From this equation, together with the budget constraint relationship, we can proceed to derive implications about the responsiveness of real per-pupil expenditure, e, to changes in each of the exogenous variables that appears in the model.

I will not reproduce here the mathematics by which the response of per pupil spending to each of the other variables is derived. The process consists of differentiating both the marginal rate of trade-off equation and the budget constraint equation with respect to each variable and then solving the pair of equations for the change in e per unit change in that variable. That is, solutions are obtained for de/dy, de/ds, de/dh, etc. The result is a set of implications, showing the expected sign of the effect on spending of a change in each variable and, in some cases, the relative magnitude of the effect. These implications lead to formulation of regression equations that can be applied to the empirical data.

Implications of the Theory

The model set forth above proves to be consistent with demand relationships of the following general form:

$$e = f(y - t_y, af, h, t_g, pac).$$
$$\quad\quad +\quad\; +\quad -\quad -\quad\; -$$

The plus or minus sign under each variable indicates whether that variable is positively or negatively associated with real per pupil expenditure. Thus, the model implies that real educational outlay should increase with increases in disposable personal income and "lump-sum" state aid and should decrease with increases in the proportion of local taxes borne by homeowners, noneducational property taxes, the relative price of education, and the local share of matching grants.

Of course, to obtain an empirically testable demand equation it is also necessary to stipulate a specific functional form for the above expression. Some empirical results from estimation of a linear form of the model are given below. However, even the general form of the model has some important implications about school district fiscal behavior. These will be discussed briefly before the empirical work is presented.

Some of the implications of the general model are intuitively obvious and others not. Among the obvious ones are the positive relationships between per-pupil spending and both disposable income and state aid. These relationships need no explanation as they are consonant with results that would be obtained by reasoning in terms of the "fiscal capacity" or "ability to pay" of school districts. Therefore, the following comments will be confined to those implications that seem less evident and that are not so frequently discussed in the school finance literature.

The Importance of Relative Price Changes. One such implication is that the relative price of education is an important variable that needs to be taken into account in developing empirical equations to explain or predict expenditure levels. There are two sources of such

variation. One is the rise in educational resource costs over time, which can be measured by increases in salaries of instructional personnel and in prices of other resources purchased by school districts. The other is differences that exist at any given time among states or localities on the supply side of the market for teachers and other educational resources. In principle, the second kind of variation would be measured by differences in salaries paid (in the case of teachers) in different areas to obtain teachers of the same quality. However, the problem of taking quality into account when comparing teacher salaries is a difficult and thus far unsolved one from a conceptual point of view, and also a difficult one practically because of the scarcity of relevant data. Consequently, the only real opportunity at present for determining the effect of relative price changes on spending is in analyzing the effects of changes in relative education costs over time. For this reason, inclusion of both cross-sectional and longitudinal data in the empirical analysis, which was referred to very briefly earlier in the discussion, is essential in testing the implications of the theory.

The Effects of Changes in State Aid. The theory yields several implications about the effect of state aid on per-pupil expenditures. One is that the effect of a given increment in aid funds will be quite different depending on whether the increment is provided in lump-sum form (that is, by an increase in the foundation level or flat grant portion of an aid formula) or by some form of matching grant. The former has the effect of changing the aid term (the term af in the demand relationship given above). The latter operates by changing the local share parameter, c, in the price term of the demand equation. In general, the two effects will be different. Moreover, it can be shown that under certain reasonable assumptions the effect of matching aid will be more stimulative than the effect of the same amount of lump-sum aid. In other words, the model implies that the overall level of per-pupil spending would tend to be increased by a shift from foundation or other lump-sum formulas to a system of matching grants, even with no increase in the amount of state aid.

A related implication, which can be derived by inspection of the demand equation, is that a decrease in the local share of a matching formula by a given fraction should have precisely the same impact on spending as a decrease by the same fraction in the relative price of education. This is a common sense result. It means, for example, that a decision by the state to finance one-third of each district's budget (assuming no state aid had been provided before) would have exactly the same effect on local behavior as a one-third reduction in the costs of all educational resources. Either way, from the point of view of the district, the same amount of resources could be obtained at two-thirds of the former price.

The equivalence of price change and matching grant effects is important in relation to the study goal of being able to predict effects of alternative aid formulas. Among the aid alternatives that we would want to analyze are many that involve some kind of matching arrangement. Yet, most states have little or no experience with matching formulas, having always provided aid via flat grant or foundation aid plans or other lump-sum formulas. The question, then, arises of how it is possible to estimate the effects of matching grant formulas in the absence of past or current experience. The theory provides an answer: If we can estimate the response of spending to changes in relative prices, we will then be able to infer probable effects of matching formulas even in the absence of direct experience. Again, this underscores the practical importance of longitudinal analysis, which is necessary if we are to determine the effects of price changes.

Another implication of the model has to do with estimation of the rate of substitution of state aid for locally financed expenditures. Although it would be convenient to have a single numerical estimate of the rate of substitution, the model implies that no such number can be obtained because the rate of substitution depends on the number of pupils per household in each district. As can be seen, that ratio, a, appears in both the lump-sum and matching grant terms of the demand equation. This means that no matter what form of aid is provided, the impact on per-pupil spending will be proportional to the number of pupils per household. Stated differently, the impact of aid on per-pupil

expenditure depends on the amount of aid provided per household or per capita in the community rather than on the amount provided per pupil. This is a result that would probably not be obtained intuitively, but that follows from the basic formulation of trade-off behavior in the theoretical analysis.

Effects of Tax Structure Variables. One useful property of this kind of analysis is that it is possible to deal simultaneously with many variables of interest. To demonstrate this capability, I have included two attributes of the tax structure in the model. One is the proportion of property taxes paid by homeowners; the other is the level of non-educational property taxes levied on residents of a school district. The significance of the first is that it focuses attention on a relatively neglected determinant of school spending, the composition of the property tax base. According to the model, the variable h, which measures the ratio of residential assessed valuation to total assessed valuation in a district, is negatively related to per-pupil spending. Since the residential portion of property value is likely to be fairly closely related to income, variations in h, holding income constant, primarily represent variations in the amount of business property per pupil from one district to another. A low value of h is associated with a greater than average amount of business property per pupil and, as would be expected, a higher level of per-pupil spending. This is consistent with a strong positive correlation between per-pupil spending and the per-pupil property tax base, as frequently reported in the school finance literature, but it suggests something other than a direct causal relationship and leads to different policy implications. Of course, like all of the other implications of the theory, this proposition about the importance of the composition of the tax base has the status of a hypothesis requiring empirical confirmation.

Inclusion of non-educational property taxes in the model is intended to demonstrate that contentions about the effects of "municipal overburden"--the negative effect on school spending of higher-than-average demands for other public services in urban areas--can be tested within the framework of a general school expenditure model. In testing this version of the model, we would look for a negative relationship

between per-pupil outlay and the level of municipal and county property taxes imposed on taxpayers in a school district. In the same spirit, the model adjusts personal income for differences in federal and state income taxes by subtracting those amounts (t_y) from the income variable. If comparisons were to be made across state lines, it would also be appropriate to adjust for differences in sales tax rates. That can be handled within the same framework though it requires a more complicated adjustment. In any case, the point is that treatment of the effects of differences in tax levels or tax structures can be readily accommodated within a constrained maximization model.

SOME EMPIRICAL RESULTS

Although the empirical work on this project has not been completed, a discussion of some interim results may help to illustrate the kinds of studies that can be based on the theory. These results are from the part of the work that deals with comparisons of educational spending among the states. That is, they are not based on financial data for individual school districts but on aggregative data representing spending by all school districts within each state.

Using selected data from the U.S. Office of Education's biennial survey of state school systems* and economic data published by the Commerce Department's Office of Business Economics, we were able to test an equation of the following form:

$$e = b_o + b_1(y - t_y) + b_2\, as + b_3 ag + b_4 pa,$$

where s and g are per-pupil grants from the state and the federal government, respectively, and the other variables are defined as before, but in per capita terms. This is a truncated version of the demand relationship shown earlier. It does not include variables representing

*U.S. Department of Health, Education, and Welfare, Office of Education, *Statistics of State School Systems, 1965-66*, U.S. Government Printing Office, Washington, D.C., December 1968, and equivalent publications for earlier years.

the composition of the tax base or the level of non-educational taxes in each state. We have not yet been able to construct appropriate sets of data for those two variables.

The relative price variable measures year-to-year variations in nation-wide unit costs of education relative to the general price level. It does not measure variations among the states. Relative costs of education in different years were obtained by extrapolating an educational cost index of the type developed by Lorne Woollatt.*

It was possible to apply the equation to data for seven school years beginning with 1953-54 and including alternate years up to 1965-66. Also, the equation was fitted to pooled data for all seven years. The table on the following page gives the regression coefficients, standard errors of the coefficients (in parentheses), the coefficient of determination (R^2), the standard error of estimate, and the coefficient of variation for each equation. For each year, the equation is able to account for from 76 to 80 percent of the variance in expenditure among states, resulting in a standard error of estimate that is about 11 percent of the mean value of real per-pupil expenditures.

It is apparent from examining the tabulated coefficients and statistics that conversion of the financial data to real terms and inclusion of an explicit price term has resulted in a model that produces consistent results from year to year. This is in contrast to some earlier studies which found the explanatory power of a cross-sectional model greatly diminished when applied to later data. Consistency over time is one bit of evidence in support of the validity of the basic formulation.

Turning to specific results, the equations seem to show that variations among states in the amount of aid provided per pupil account for only a very small part, if any, of the variation in per-pupil expenditure once other variables have been taken into account. In other words, increases in the proportion of school expenditures financed by the state appear to have only a slight positive effect on expenditure

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*Lorne H. Woollatt, "The Cost of Education Index, 1939-1958," Bureau of Research, Baltimore Public Schools, Baltimore, Maryland, December 1958 (mimeo).

Table

REGRESSION RESULTS FROM AN INTERSTATE COMPARISON
OF EDUCATION EXPENDITURES

$$e = b_o + b_1 (y - t_y) + b_2 as + b_3 ag + b_4 pa$$

Year	b_0	b_1	b_2	b_3	b_4	R^2	*Std. Error of Estimate*	*Coeff. of Variation*
1953-54	159	.132 (.021)	.370 (.444)	1.49 (2.19)	-645 (251)	.76	31.9	.12
1955-56	189	.123 (.022)	.639 (.410)	2.70 (2.07)	-729 (251)	.76	31.5	.12
1957-58	152	.139 (.018)	.699 (.280)	3.88 (1.35)	-643 (203)	.81	29.5	.11
1959-60	116	.153 (.021)	.289 (.311)	2.46 (1.13)	-479 (219)	.78	31.3	.11
1961-62	173	.146 (.019)	.290 (.306)	2.11 (1.11)	-605 (213)	.77	32.4	.11
1963-64	131	.154 (.019)	.390 (.272)	2.27 (1.04)	-504 (201)	.76	34.1	.12
1965-66	106	.163 (.017)	.543 (.214)	1.72 (.842)	-492 (180)	.79	32.9	.10
Pooled	60	.162 (.005)	.424 (.108)	1.95 (.416)	-308 (42.7)	.78	31.9	.11

levels. Federal aid appears to have a more significant additive effect on spending, although the values of the coefficients applicable to federal aid per capita, which run about 2.0, correspond to only about 40 to 50 percent additivity of federal funds per pupil. Of course, the analysis is not yet complete and changes in the form of the equation or inclusion of additional variables may significantly modify the results.

An analysis of the differences between actual and predicted values of per pupil expenditures for individual states revealed that at least one additional factor needed to be taken into account. This was a South versus non-South regional difference. Our results confirmed the finding reported by others that expenditure levels in the South were significantly lower than in the rest of the country even after income

differences were allowed for.* However, in the attempt to include a regional variable in the regression equation, it was found that the regional effect was somewhat more complicated than had been expected, as is illustrated by the following two equations:

1. No regional variable:

$$e = \underset{}{60} + \underset{(.005)}{.162\ (y - t_y)} + \underset{(.108)}{.424as} + \underset{(.42)}{1.95ag} - \underset{(43)}{308pa} \qquad R^2 = .78$$

2. Regional variable included ($R = 1$ if a southern state; 0 otherwise):

$$e = \underset{}{117} - \underset{(10.6)}{66R} + \underset{(.007)}{.126(y - t_y)} + \underset{(.10)}{(.55} + \underset{(.29)}{.79R)as}$$

$$+ \underset{(.38)}{197.ag} - \underset{(40)}{275pa} \qquad R^2 = .82$$

Notice that the explanatory power of the equation improves when the regional variable, R, is included and that R appears twice in the second equation: first, as an additive term; second, as a term modifying the coefficient of state aid. This means that per-pupil expenditure is lower in the South, other things being equal, and also more responsive to the level of state-local transfers. It remains to be determined whether the latter difference can be attributed to specific characteristics of the school aid formulas used in the South. We also tested the same regional variable in the cross-section equations for individual years and found an even larger improvement in the equation statistics. However, those results showed a diminishing trend in the regional effect, to the extent that it was impossible to demonstrate a significant South versus non-South difference in 1965-66, the final year of the analysis. This is a finding with potential policy significance, but one that needs to be confirmed by further work.

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*A South versus non-South difference in expenditure patterns was reported by James in the study cited earlier. Also, see Sherman Shapiro, "Some Socioeconomic Determinants of Expenditures for Education: Southern and Other States Compared," *Comparative Education Review*, October 1962.

This method of dealing with a dichotomous regional variable also serves to illustrate a general technique that can be used in testing hypotheses about effects of other political, social, or geographical variable on school spending. Many such variables have been proposed in the literature; for example, population density or sparsity, urbanization, political "liberalism" or "conservatism," fiscal dependence or independence of school districts, and the educational level of the adult population have all been cited as possible determinants of school spending. But in most cases we do not know *a priori* whether these are independent influences on fiscal behavior or, if so, how they should enter into the model. A "dummy variable" technique of the type used in the regional analysis allows for preliminary testing of these hypotheses. If they prove to have a significant effect on either the constant term of the demand equation or on individual coefficients, further tests can be conducted of alternative hypotheses concerning the form in which they should enter the model.

At the present time, we are seeking to extend and improve the analysis in several respects. First, as was mentioned, we hope to be able to include variables to represent variations among states in the composition of property tax bases and in levels of state taxes and local taxes for functions other than education. Also, we have been experimenting with different ways of developing measures of differences in education costs and in the general price level among states. Finally, we are now trying to systematically compare state aid formulas among states to see whether differences in the characteristics of aid formulas can be used to help explain expenditure variations, especially the North-South differences in the responsiveness of expenditures to levels of aid.

Apart from these improvements, we will shortly be able to extend the scope of the analysis considerably by making use of the annual estimates of state school statistics compiled by the Research Division of the National Education Association.* Using those data, which provide

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*National Education Association, Research Division, *Estimates of School Statistics*, compiled for 1969-70 and prior years.

a continuous 17-year time series on state school expenditures and revenues, we will be able to look at behavior over time of individual states as well as annual cross-sections. This should make it possible to test a number of hypotheses about the fiscal behavior of state school systems that could not be investigated with the biennial U.S. Office of Education data.

USING A MODEL IN POLICYMAKING

At the outset, I identified the goal of this project as being able to assist decisionmakers at the state or federal level in choosing among alternative aid formulas. Therefore, having discussed the technical aspects of the work at some length, it seems appropriate to refer back to that objective and say a few words about how econometric expenditure models may be used as policymaking tools. As an illustration of the potential applicability of such a model, I will suggest how it might be used at the state government level in planning state financial aid to local school districts.

Spppose that a state education department or the education committee of a state legislature is considering a number of proposals for changing an existing foundation aid plan: One alternative might call for distribution of an additional flat grant per pupil; another might call for an increase in the equalized foundation program; a third might call for replacement of the foundation aid formula with a plan for state matching of locally-provided funds. Each plan can be represented by a number of aid formula parameters. Depending on the formula, these parameters might include the level of flat grants, the foundation level, the minimum required local tax rate (if applicable), the local share (for the matching plan), and so forth.

Assume that a model has been developed that predicts school district expenditures from information on district income, population, ADA, property value, and other variables, including the values of the parameters of the aid formula. Assume that data on the relevant variables are available for each district or for each of several classes of districts in the state. In analyzing each alternative the analyst would apply the model to each district or class of district, inserting

the appropriate values of district characteristics and aid parameters. He would obtain estimates of total and per-pupil educational expenditures that would be forthcoming under that alternative. From these he would calculate any of a number of measures of fiscal impact that might be of interest to concerned executives or legislators. For example, one relevant measure might be the change in local educational outlay per dollar of state aid. This would indicate the degree to which a proposed aid increment would be likely to add to or substitute for local educational spending. Such a measure could be calculated both for the state as a whole and for specific categories of districts. Other measures would include different indexes of inequality of educational expenditures per pupil among districts. These would serve as indicators of the distributional impact of the aid proposal. Of course, to make comparisons possible, the same measures would be calculated for all alternatives, including the "null" alternative represented by continuation without change of the existing aid formula.

It would be the job of the responsible decisionmakers to assign weights to the different indexes of aid "performance" to use in evaluating and choosing among the alternatives. Or, the analyst might suggest new alternatives that could combine desirable features of two or more of the original proposals. Thus, an iterative process might ensue in which the fiscal impact model was applied at each stage until a preferred alternative was selected.

Why would such information be desirable? As things now stand, officials considering proposed changes in state education aid formulas are able to look at data on the amount of aid to be received by each district, the existing level of expenditure in each district, and the total cost of alternative aid plans to the state. They are provided with no information, because none is available, on the probable fiscal response of the districts to enactment of the different plans. Consequently, either the officials can draw no conclusions about how the plans will affect expenditure levels or, what is more likely, they judge each plan as if all of the increased aid were to be added to the existing level of district expenditure. In general, the latter would not be correct. Some aid formulas may result in substitution of increased

state aid for local funds; some may stimulate increased local spending. It is even possible that one plan would produce a greater overall increase in educational spending than another that requires greater outlays by the state. Moreover, because alternative aid arrangements may have differential effects on different districts, it is possible that two plans could have dissimilar distributional impacts even though they appear to involve similar patterns of aid apportionment. Therefore, since the full implications of an aid formula are unlikely to be readily apparent, analysis may well lead to development of a better plan than might otherwise have been selected.